Nomination of

FISH RIVER WATER SUPPLY SCHEME

as a

National Engineering Landmark

Contents

1.0 INTRODUCTION

The Fish River Water Supply Scheme [FRWS] is a medium size but important water supply with the headwaters in the Central Highlands of NSW, west of the Great Dividing Range and to the south of Oberon. It supplies water in an area from Oberon, north to Portland, Mount Piper Power Station and beyond, and east, across the Great Dividing Range, to Wallerawang town, Wallerawang Power Station, Lithgow and the Upper Blue Mountains. It is the source of water for many small to medium communities, including Rydal, Lidsdale, Cullen Bullen, Glen Davis and Marrangaroo, as well as many rural properties through which its pipelines pass. It was established by Act of Parliament in 1945 as a Trading Undertaking of the NSW State Government.

The FRWS had its origins as a result of the chronic water supply problems of the towns of Lithgow, Wallerawang, Portland and Oberon from as early as 1937, which were exacerbated by the 1940-43 drought. Small local schemes were rejected in favour of a regional system, but delays in funding blocked any commencement of works.

The advent of WWII provided the impetus needed to restart the stalled project. The need for an indigenous supply of petrol saw the scope of the scheme extended to include a water supply to the shale oil works at Glen Davis, which became the key to the provision of Commonwealth funding.

The early fifties saw the closure of the shale oil works and the birth of a new energy-based industry; electricity generation. As a result the power station at Wallerawang became a FRWS consumer. Increasing demands at the power station as its capacity was expanded, and by the communities in the Blue Mountains, were the catalyst for augmentation of the scheme. The Oberon (slab and buttress) Dam was raised to its full design height making it the largest of its type in Australia. Two new pipelines, to Wallerawang and to the Blue Mountains, were constructed, both of which have significant and unusual engineering features.

Further expansion of the source in the 1960s, although economically very attractive, was abandoned in a landmark decision based entirely on environmental considerations.

The FRWS exhibits many features of heritage significance as traversed below. Based on a detailed evaluation of these it is recommended it be declared a National Engineering Landmark.

This document has been prepared by Denis Barrett, B. E., M. Eng. Sc. He was for many years responsible for the day to day running of the scheme and is part author of the book, *"Let's Have Water – A History of the Fish River Water Supply"*.

2.0 NOMINATION FORM

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of work: **Fish River Water Supply Scheme**

The above-mentioned work is nominated to be awarded a **National Engineering Landmark**

Location, including address and map grid reference if a fixed work:

The scheme extends across the local government areas of the Shire of Oberon, the City of Lithgow and the City of the Blue Mountains. Its administrative office is at 65 Portland Road, Wallerawang NSW 2845.

Owner (name & address) **State Water Corporation**
Level 8, Macquarie Tower
2-10 Wentworth Street
Parramatta NSW 2124

The owner has been advised of this nomination, and a letter of agreement is attached.

Access to site: **Access to individual parts of the scheme is by many different public roads and in some cases, right-of-way access through private land. Directions for access to a particular component should be obtained from the administrative office at Wallerawang.**

Nominating body: **Sydney Engineering Heritage Committee**

(Signed)………………………………………
Chair of Nominating Body

Date: ……………………

This plaquing nomination is supported and is recommended for approval.

(Signed)……………………………………….
Chair of Division Engineering Heritage Group

Date: …………………………….

State water

Contact: Warwick Battye-Smith
Phone: 02 63551106
Fax: 02 63551566

Our Ref: A16

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

21 April 2008

Dear Sir/Madam

Re: Fish River Water Supply Plaquing Nomination Submission

It is with great pleasure that I commend this plaquing nomination submission to "Engineering Heritage Australia" for consideration. The Fish River Water Supply scheme has played a key role in the engineering development of this country and would be a worthy recipient of the National Engineering Landmark award.

Yours sincerely

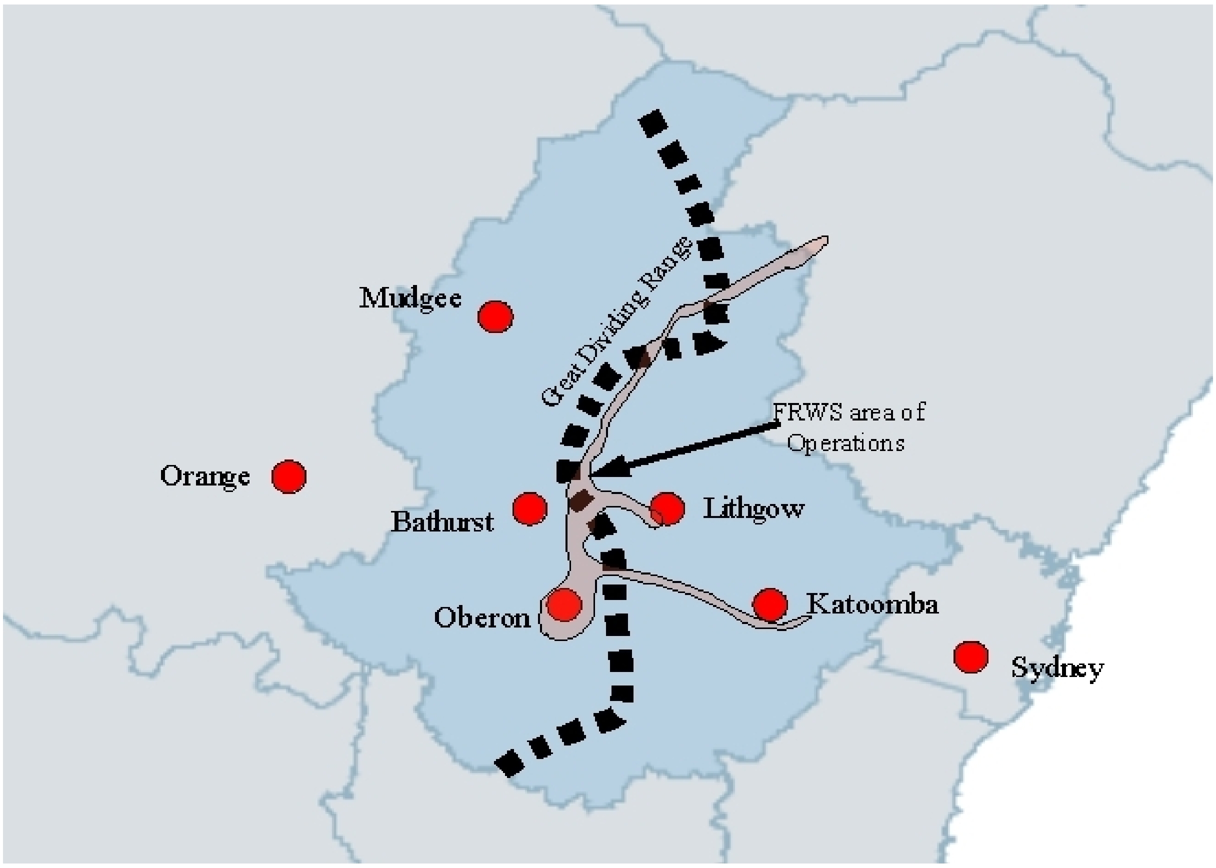
Warwick Battye-Smith
Operations Manager
Fish River Water Supply
State Water Corporation

3.0 LOCATION OF FISH RIVER WATER SUPPLY SCHEME

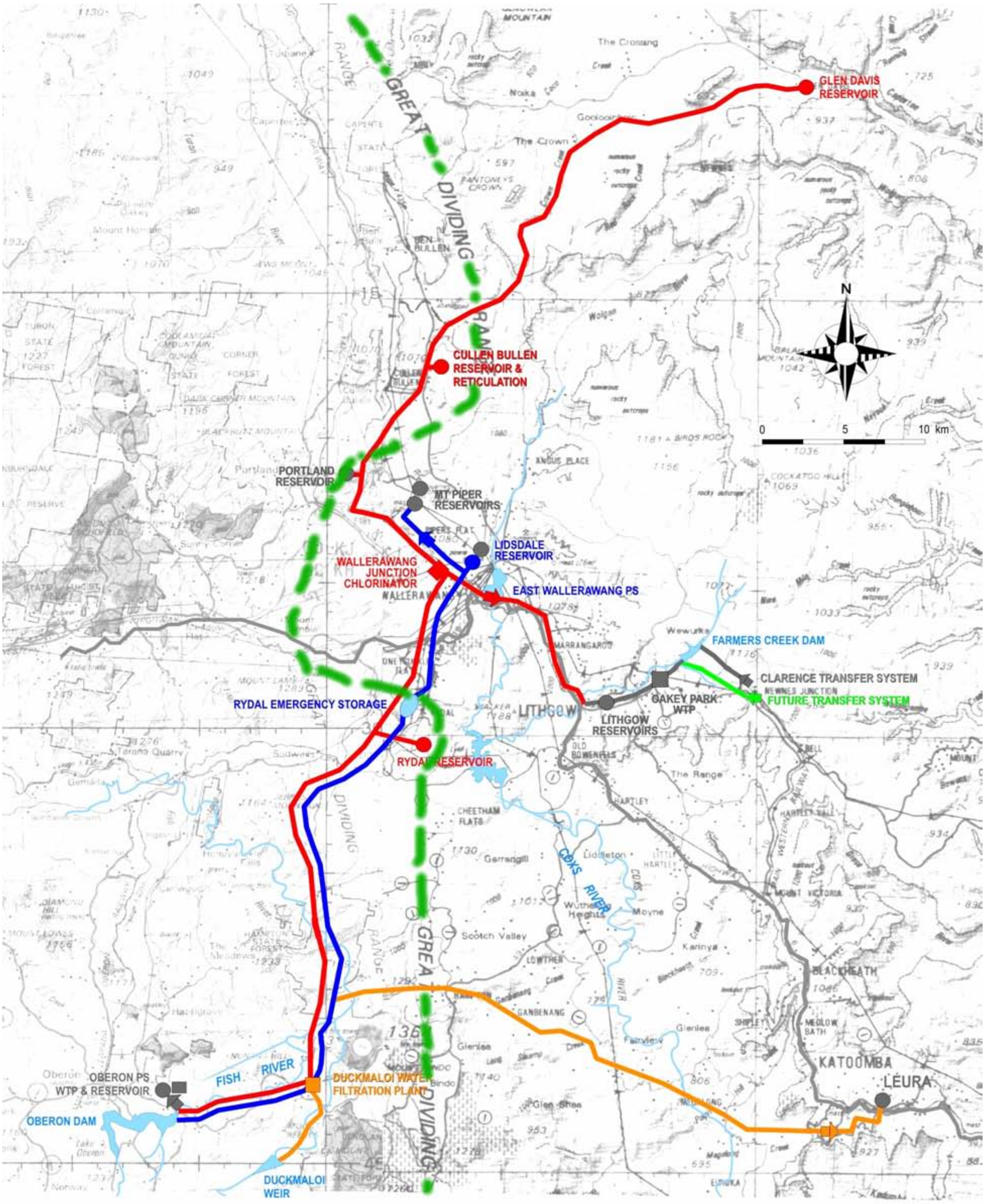
A map showing the Central Tablelands of NSW [darker shade of blue] with the FRWS area of operations superimposed is shown below.

The figure on the following page shows the area of operations of the FRWS in greater detail. Its installations are shown in red, blue or orange, corresponding with the three significant stages of development of the scheme. Other water supply features shown in grey [such as the Clarence Transfer System or Mount Piper Reservoirs] are owned and controlled by either local government authorities or the electricity generating authority.

The map shows that apart from the townships of Oberon and Portland, the villages of Rydal and Cullen Bullen and some "minor consumers" connected directly from the pipelines, most of the water delivered from the scheme is consumed on the eastern side of the Great Dividing Range.



FRWS and its location within the Central Tablelands



FISH RIVER WATER SUPPLY
AREA OF OPERATIONS

Legend: Stage 1 components shown in red — Stage 2 components shown in blue
Stage 3 components shown in orange — Broad arrows represent pumping stations
Components shown in grey belong to other operating authorities

4.0 GLOSSARY, ABBREVIATIONS AND UNITS

4.1 Glossary

Ambursen	An American engineer who in 1903 was the first to design and construct a buttress dam with a sloping reinforced concrete slab spanning between buttresses.
Buttress dam	A buttress dam consists of an impermeable face supported by a series of buttresses spaced across the valley.
Booster Pump Station	A pump station which increases the rate of flow through a pipeline.
Break Pressure Tank	A small tank into which an upstream length of a pipeline discharges. Downstream pressures are controlled by the top water level of the tank.
Central Highlands	That part of the Central Tablelands close to the Great Dividing Range with a sub-alpine climate.
Central Tablelands	An area of NSW to the west of Sydney, extending westward from the eastern slopes of the Great Dividing Range to the plains beyond.
Fuse Plug Spillway	A spillway designed to fail when overtopped, to relieve flood flows and prevent damage to a dam
Pipehead Weir	A small weir designed to pond "run-of-river" flows.
Pressure Reducing Valve	A valve designed to limit the maximum pressure in the pipeline downstream to a pre-set value
Safe Yield	The maximum annual supply that can be taken such that a water source will survive the theoretical worst drought.
Scour	Erosion damage from high velocity water flows
Ski-Jump Spillway	A spillway with a curved bucket that throws dam overflow well clear of the structure to prevent scour damage to the dam foundations.
Slab and Buttress	A form of dam construction with sloping reinforced concrete slabs spanning between buttresses.
Terminal Storage	A storage at or near the end of a pipeline, used to maintain supply in the event of pipeline failure or when temporary peak demands exceed pipeline capacity.
Turbidity	A measure of particulate matter being carried in water.

4.2 Abbreviations and Units

AWC	Allied Works Council. [A body that oversaw civil defence projects during WWII]
BPT	break pressure tank
CCC	Civil Constructional Corps. [Volunteers or draftees who worked on defence related projects in WWII]
FRWS	Fish River Water Supply
km	kilometre
m	metre
m. gal.	million gallons. [One million gallons = 4.55 megalitres]
ML	megalitre. [1,000,000 litres]
ML/a	megalitres/annum
mm	millimetre
NSW	New South Wales
PRV	Pressure Reducing Valve
PSC	prestressed concrete
PWD	Public Works Department, NSW
WTP	Water Treatment Plant
WWII	World War Two

Record flow passing over the Oberon Dam spillway in 1990

5.0 HERITAGE ASSESSMENT

5.1 Basic Data

Item Name:	Fish River Water Supply
Other/Former Names:	Nil
Location (grid reference if possible) Address:	The scheme extends across the local government areas of the Shire of Oberon, the City of Lithgow and the City of the Blue Mountains. Its administrative office is at 65 Portland Road, Wallerawang NSW 2845.
Suburb/Nearest Town:	NA
State:	NSW
Local Govt. Area:	See address
Owner:	State Water Corporation
Current Use	Domestic, industrial and rural water supply
Former Use (if any)	NA
Designer	Public Works Department, NSW
Maker/Contractor (Major components)	Oberon Dam: Public Works Department, NSW Pipeline (Stage 1): Public Works Department Pipeline (Stage 2): Rocla Pipes Ltd (supply and pipe-laying) Pipeline (Stage 3): Humes Ltd (supply and pipe-laying)
Year Started: Year Completed:	23.10.1943; latest augmentation (fuse plug spillways at Oberon and Rydal Dams) completed in 1995
Physical Description:	Concrete buttress dam on Fish River near Oberon, weir on the Duckmaloi River, a water treatment plant and extensive pipeline network supplying water to Oberon, Portland, Mount Piper Power Station, Wallerawang town, Wallerawang Power Station, Lithgow and the Upper Blue Mountains
Physical Condition:	Good
Modification and Dates:	Fuse plug spillways for Oberon and Rydal Dams completed in 1995

Heritage Listings (information for all listings): Nil

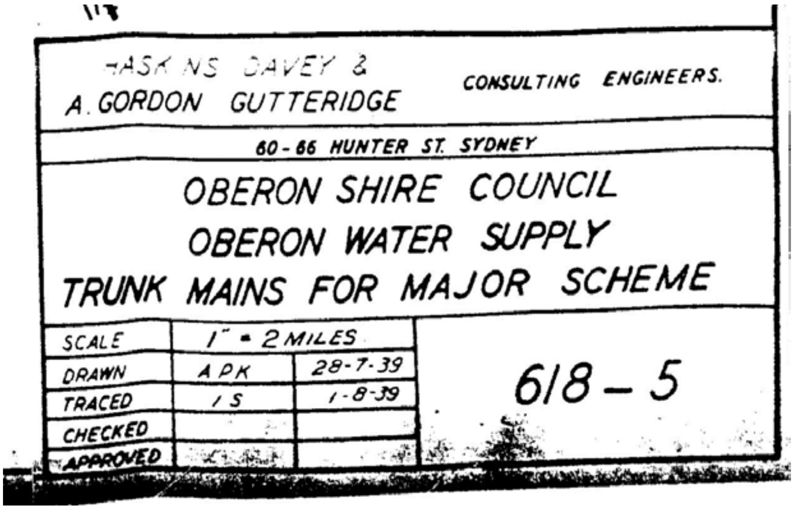
5.2 Heritage Significance

5.2.1 Historic Phase

Genesis

The history of the FRWS, from the recognition of need for a reliable water supply in the Lithgow area, to the approval to proceed in 1943 makes an interesting study. The many alternatives considered and rejected, the implication of WWII and the political issues that involved Local, State and Commonwealth Governments make the history lengthy and complicated. The detailed history may be read in the book *"Let's Have Water – The History of the Fish River Water Supply"*. (Reference 1)

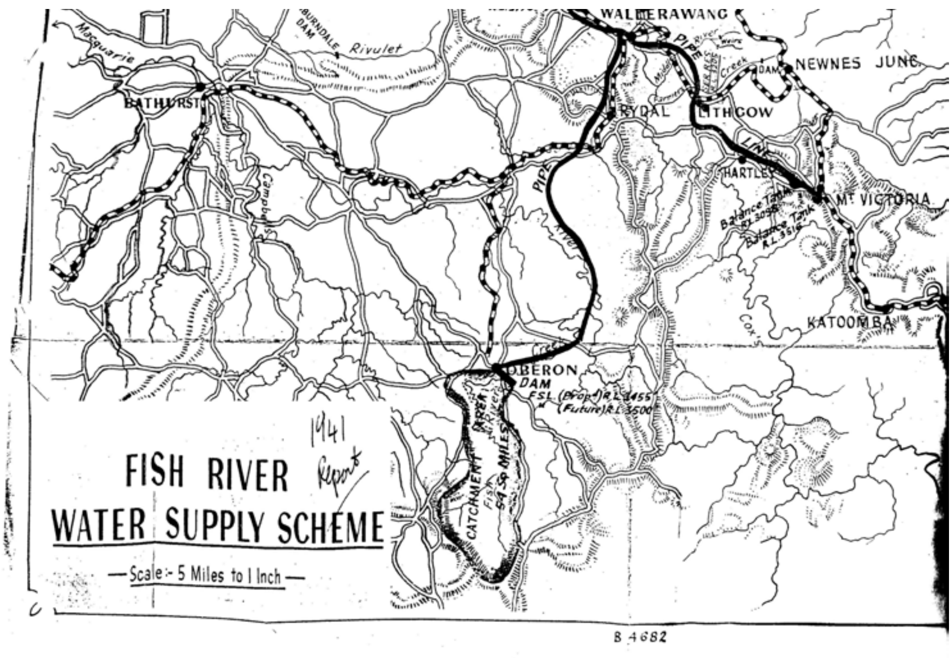
The genesis of FRWS lies in the response to the ongoing water supply shortages, during the 1930s, of Lithgow, Oberon and the communities of Blaxland Shire. Many schemes were considered but lack of funding and inadequacies in the concepts proposed saw none of them proceed. In 1939, a report by Gerald Haskins produced for Oberon Shire Council recommended a scheme which provided a solution to Oberon's own water needs, but recognised the potential offered by a dam on the Fish River Creek for a system to serve communities from Bathurst to the Blue Mountains.



Title Block from one of the Haskins Drawings

The Haskins report provided the basis for the scheme presented in February 1941 by Stephen Jones, the Principal Engineer Water Supply and Sewerage of the NSW Public Works Department.

There were some significant differences between the Haskins' and Jones' reports. The former recommended a branch line to augment the Bathurst water supply. This was abandoned by Jones on the grounds that there was an insufficient quantity of water at the source for both Bathurst and the Blue Mountains. (In the event Jones was proved right as the PWD completed Chifley Dam on Campbells River in 1956, to serve Bathurst exclusively). Haskins proposed a pumping station at Oberon lifting water to a balance tank from where it would flow by gravity to the various destinations, including the Blue Mountains. Jones, chose a more rugged pipeline route that allowed supply by gravity to consumers other than those in the Blue Mountains, who would be supplied through a pumping station near Mount Victoria. By proposing a scheme where only the water delivered to the Blue Mountains was pumped, Jones had found a means to reduce energy costs.



Part of one of the drawings in the "Jones Report"

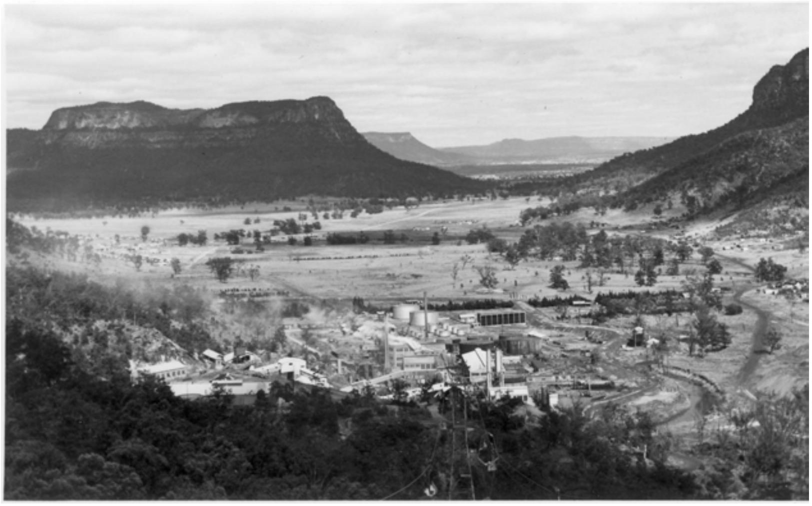
Jones proposed a slab and buttress dam 55 feet [17 metres] high impounding 2000 million gallons [9100 ML] with pipelines delivering water to Wallerawang, Lithgow, Portland and Glen Davis. The estimated cost was nearly £500,000, a very large sum for a government still recovering from the Great Depression and affected by WWII. Progress on the project became stalled by a lack of funds.

The Haskins' and Jones' concepts agreed on the potential of the dam site. Both proposed construction of a dam that could be raised to a height of 100ft [30.5 m] at a later stage, to meet expected increased demands in the Lithgow area and the additional supply to the Blue Mountains.

As an aside, Gerald Haskins, partner in the consulting engineering firm of Gutteridge, Haskins and Davey (now GHD) retired to his farm at Oberon in 1942. From there he could watch the progress of "his" scheme. He died in early 1946 as Stage One was nearing completion.

The drought of the early 1940s exacerbated the local town water supply problems and lower cost local schemes were again considered by the Councils concerned.

It was, however, the impact of the war that allowed the FRWS scheme to proceed. Shale oil production at Glen Davis was considered to be crucial to the Australian war effort and the Commonwealth Government eventually agreed to contribute to the capital cost of the project on the condition that an adequate supply of water was delivered to Glen Davis for oil production. Indeed, the Commonwealth's decision to provide funding, which was ratified by a Full Cabinet decision in June 1943, was contingent upon priority of supply being given to the National Oil Refinery at Glen Davis before any town supplies.


View of Glen Davis circa 1943 showing the Oil Refinery

It was agreed that the works would be undertaken by the NSW Public Works Department [PWD] with the Allied Works Council [AWC] supervising it as a priority defence project.. FRWS received a high priority of importance as a defence work, which assisted in securing labour. A decision was also made that labour for FRWS would be provided by the Civil Constructional Corps [CCC] working a 54 hour week rather than the usual 44 hours.

The CCC was formed in April 1942 in the aftermath of the initial Japanese offensive as a major wartime effort to organise civilian manpower for the defence of Australia. At its peak strength in August 1943, almost 54,000 men were serving in the CCC. They were involved in hundreds of projects worth millions of pounds. By the end of the war 77,500 men had served in the CCC. They had served in every state and territory and made an invaluable contribution to the war effort. Two hundred and eighteen members of the CCC died while serving in it.

The Corps was given the specific task of providing labour, both skilled and unskilled for the building of roads, army camps, airfields and other works necessary for the defence of Australia. The CCC provided nearly all the labour for the first two years of the FRWS project, including the Glen Davis pipeline, with the first of the men arriving at Oberon in September 1943. The CCC was disbanded in October 1945. At the peak of activity, there were more than 400 CCC men engaged on the project.

Despite the fact that the scheme received its approval to Federal funding on the basis of the supply to Glen Davis, the designers never lost sight of the long term potential for the storage. To quote a PWD report:

> *"The Public Works Department took the view that this favourable storage site should not be expended on a small structure, but that provision should be made for full economic development of the site. Although it then had no fore-knowledge of any great expansion in demand, it proceeded to design a 10,000 m. gal. dam and to build the initial 2500 m. gal. structure in conformity with that design."*

This flexibility was made possible by the agreed funding arrangement which saw the Commonwealth meeting the major portion of the cost of the pipeline to Glen Davis and the State Government with appropriate contributions from local government, taking full liability for the cost of the dam.

Stage 1 Construction

The Stage I works comprised:

- The first stage of Oberon Dam (constructed to a height of 21.3 metres)
- A 105 kilometre pipeline from Oberon Dam through Wallerawang and Portland to Glen Davis.
- A Pump Station and main to the Oberon town reservoir .
- A 15 kilometre branch pipeline from Wallerawang to Lithgow.

On the 23rd October, 1943, work officially commenced with the "turning of the first sod" ceremony at the Oberon dam site performed by Premier McKell. Immediately it was apparent to any observer that this was to be a special dam. Foundation preparation was different to that of any large dam previously constructed in the State, as it almost immediately displayed the shape of the buttress footings, quite different to any other type of dam.

Buttress Construction at Oberon Dam

In 1943, Public Works had a distinguished record building gravity and arch dams, and it was a matter of great interest that the relatively rare slab and buttress design was chosen at Oberon. Existing records provide no clear explanation of the selection. However, it is reasonable to argue that the following factors would have strongly influenced the decision:

1. A dam constructed of earth and rock would have required significant earthmoving plant, much of which was already deployed for war effort activities and was not available for a new project.
2. The design chosen was very efficient in the use of materials, but labour intensive. The cost of labour was not as significant then as it was to become, and supply of labour was guaranteed through the Civil Constructional Corps.
3. The raw materials of cement, sand and aggregate for the concrete structure were available locally in good quantity.

Oberon in 1943 was a small isolated community with few services. Roads were poor and access to the Blue Mountains and Sydney was cut by the Duckmaloi River after any significant fall of rain.

Accordingly, a large construction camp was established close to the dam site and construction was supported by two blacksmith's shops, a plumber's shop, a rigger's shop, a machine shop and a carpenter's shop.

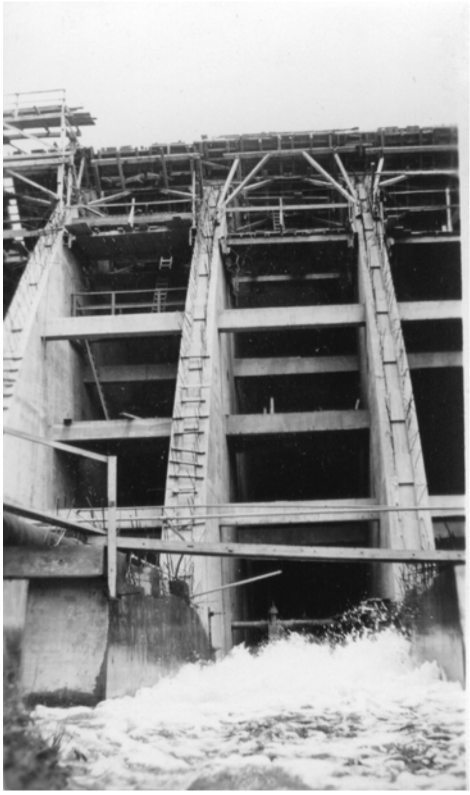
Records of the dam construction are still retained in various archives and detail the decisions that had to be made to accommodate the conditions encountered on this isolated site, including the precautions for handling extended cold weather, with temperatures sometimes down to -8°C.

The dam was constructed to a height of 21.3 metres, although the foundations and buttress bases were completed to accommodate subsequent raising to the maximum design height. A spillway 16.7 metres wide was incorporated in the left side bays with a semi-circular crest constructed at the top of the slabs. This superseded spillway is still visible.

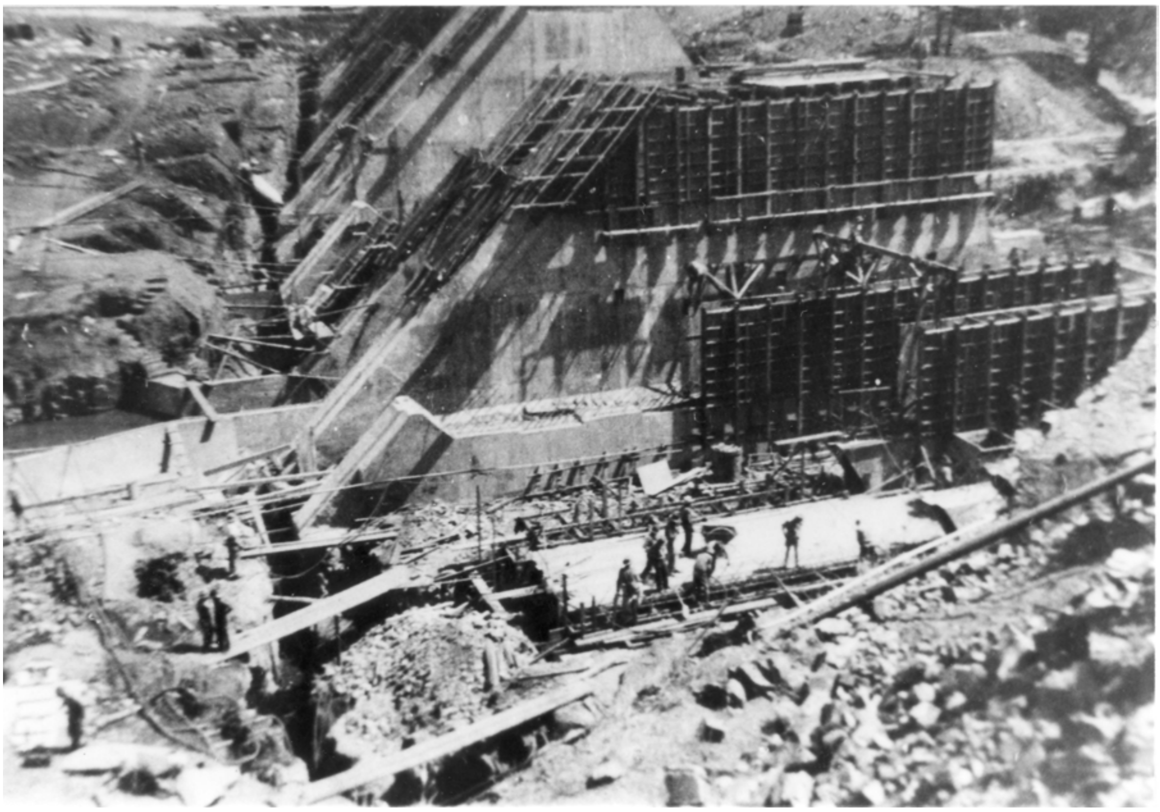
A postcard view of the completed Stage One Oberon Dam

Photographs taken during the Stage One construction of Oberon Dam

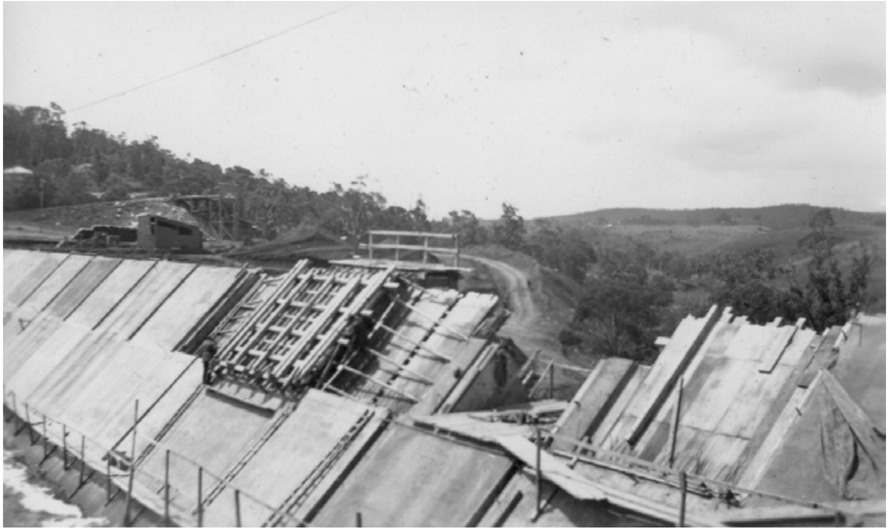
Pouring concrete for a slab

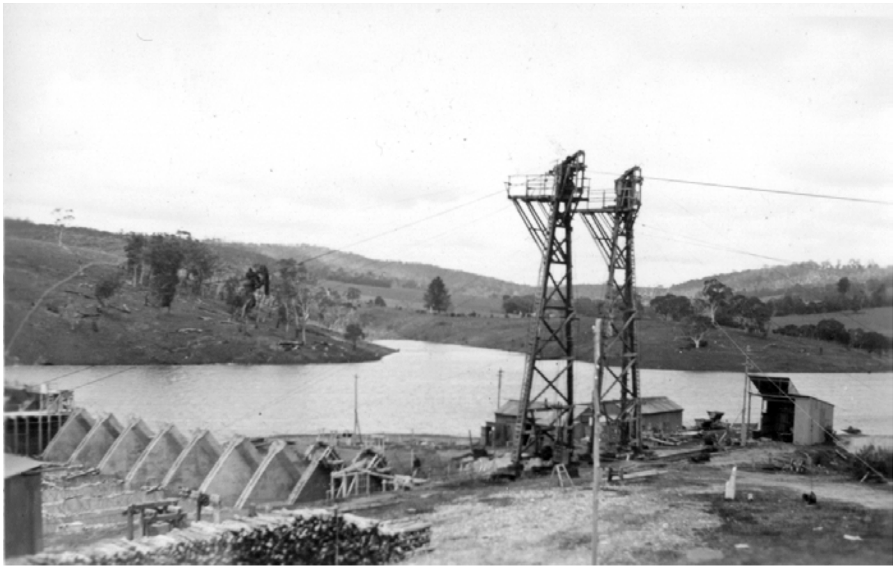


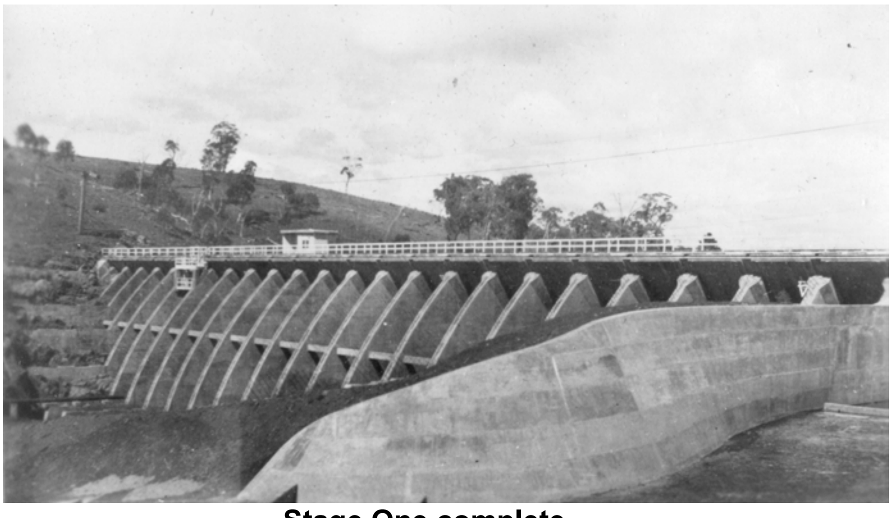
Downstream view – passing a minor flood during construction



Buttress foundations – early stages of construction of the dam


Upstream view – slabs under construction


View showing buttresses and cableway towers

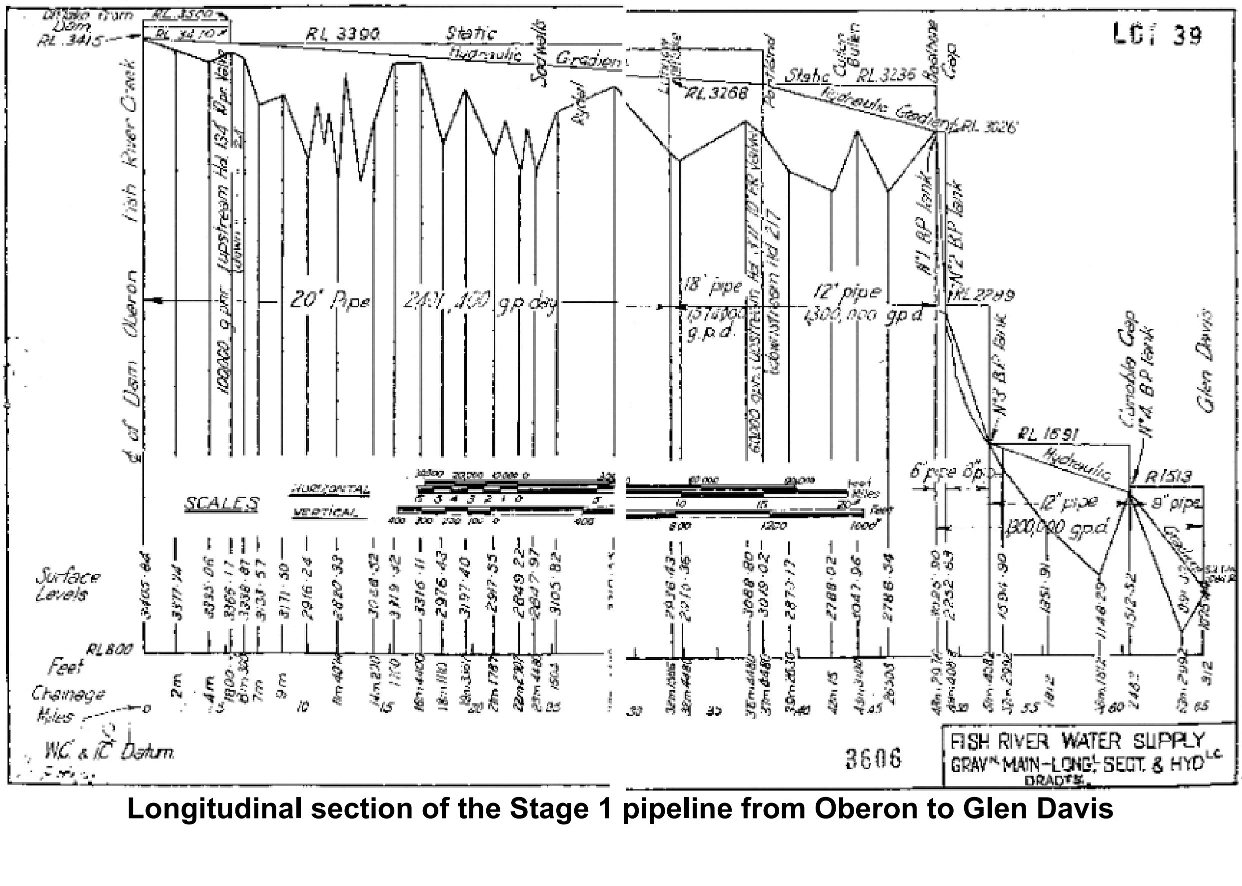

Stage One complete

In anticipation of the scheme proceeding surveying had begun in 1942. Consequently, the route of the 105 km pipeline to Glen Davis had already been determined by the time construction began.

The concept for the pipeline was based on the use of welded steel as the preferred material. However, because of the demands of the war effort, steel was excluded except for about 5 km where very high pressures were to be encountered. The pipeline to Glen Davis became one of composite materials, as follows:

5 km cement-lined welded steel [very high head areas]
82 km cement-lined lead-jointed cast iron [heads above 99 metres]
14 km reinforced concrete
4 km fibrolite

The pipeline passed through steep rugged country for much of its route and carried water from a top water elevation of 1067 metres at Oberon Dam to the reservoir level of 330 metres at Glen Davis.



Longitudinal section of the Stage 1 pipeline from Oberon to Glen Davis

To handle this difference in elevation and to accommodate the compromise that had been made in the choice of materials, a pressure reducing valve was installed at Duckmaloi and set to give just sufficient head to ensure the required flow as the pipeline crossed the Great Dividing Range near Rydal at an elevation of 968 m. Head was further lowered by a pressure reducing valve at Portland and a series of four break-pressure tanks were installed on the precipitous descent of 600 metres of the escarpment from Baal Bone Gap to Glen Davis. Over the steepest 2.4 kilometres of the descent, levels fell by 240 metres.

The nature of the country through which the pipeline passed was so rugged and steep that much trench excavation had to be done by hand. In many areas mobile cranes could not gain access to the trench and pipes were rolled into position by hand.

There were other components of the Stage 1 works.

Oft-takes were provided on the main pipeline for Council to provide reticulated water to Wallerawang and a short pipeline was built to supply Portland reservoir.

From Wallerawang, a spur line was constructed to augment Lithgow's water supply. It, too, was a pipeline of composite materials comprising both lead-jointed cast iron and reinforced concrete pipes. The country through which the pipeline passed was not difficult and construction was of a routine nature.

A small pump station was connected to the main pipeline about one kilometre downstream of Oberon Dam. It delivered water through a short rising main to a new reservoir serving Oberon township.

Oberon Pump Station

Shortly after construction was complete, reticulation was provided to the villages of Rydal, Cullen Bullen and Lidsdale. These systems were supplied directly from the FRWS pipeline and those using the water became "minor consumers" of the scheme. It was not until quite recently that the supply for these communities was upgraded and transferred to Lithgow Council.

Stage 1 of the FRWS has no clear date of completion. By March 1946, limited quantities of water were being received at the Glen Davis refinery. The dam was largely completed by mid 1947, but minor finishing work was still in progress until 1949. The last connections were to the houses in Glen Davis township in 1949.

Expansion of FRWS – Stage 2

By the early 1950s significant changes were taking place in local development and consequently in the demand for water.

Oil production at Glen Davis ceased after only a few years of operation at a significant level of output; the end of the war had brought a return of cheap oil from overseas sources, Glen Davis shale oil production was expensive, and so had become an unnecessary operation.

With the close of the oil refinery the township of Glen Davis dwindled rapidly and 2000 ML/a of water became available for use elsewhere. The population of Lithgow, which had been boosted by defence industry such as the Small Arms Factory also began to subside to pre-war levels, thus reducing demand for water.

Following the war the State underwent rapid industrialisation with consequent increases in the demand for electricity. The Government chose to implement the next stage in its generation strategy with a power station at Wallerawang close to the western coalfields. The new power station would need large quantities of water - 8,200 ML/a initially with a probable future increase to 27,000 ML/a.

In the Blue Mountains water restrictions were common, while a substantial increase in population and therefore water demand was predicted; clearly the need for increased supply could not be met from existing sources.

In 1954, the PWD undertook a major economic and engineering review and concluded that only two river systems, the Fish and the Cox's could provide a practical affordable source for the projected water demands.

Augmentation of FRWS presented the most attractive option in both the immediate future and the longer term. The elevation of Oberon Dam which would allow supply by gravity to Wallerawang was a most important factor in the decision. The nearest reasonable dam site on the Cox's River was several kilometres downstream of the power station, but the storage basin was inadequate (limiting system yield) and more importantly, there would be a static pumping head of 230 metres. Furthermore, water from Oberon was of better quality than that from the Cox's, allowing reduced treatment costs for boiler feed water.

Oberon Dam raised to its maximum design height was a suitable source, whilst close by on the adjacent catchment of the Duckmaloi River there was a site for another major source of similar height, capacity and yield as Oberon Dam.

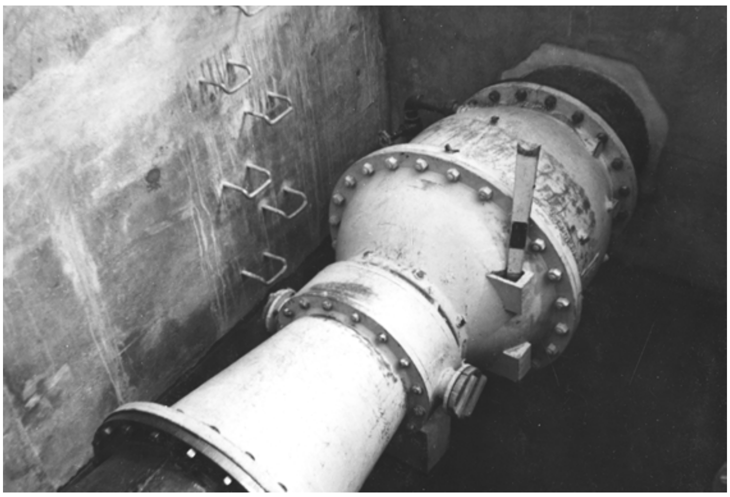
Although the original planners had not been aware of the power station to be built at Wallerawang their wisdom in building the dam foundation to support raising to full height on the grounds that there would be significant increased demands in the future, became apparent.

The concept for FRWS proposed by Stephen Jones in 1941 was re-examined. A significant change was made to the supply system for the Blue Mountains. Jones proposed to lift water some 130 metres from a pumping station near the foot of Victoria Pass to Mount Victoria, from where a gravity system would have supplied all Blue Mountains towns.

The revised system provided for a connection at Leura, a lower point in the Blue Mountains and in conjunction with a decision to pass water under the Great Dividing Range in a tunnel, it became possible to augment the Blue Mountains water supply by gravity.

Work began on Stage 2 of FRWS in 1954 on a project that included the following components:

- Raising of Oberon Dam and outlet tower from 21.3 m to full design height of 33.5 m.
- A ski-jump spillway built into the main wall of the dam.
- A new pipeline from Oberon to Wallerawang to serve the new power station.
- A break-pressure tank near Duckmaloi to combine flows from Oberon, the future. Duckmaloi Weir and the planned Duckmaloi Dam, and to control pressures in the downstream pipeline.
- Rydal Emergency Storage, a substantial terminal reservoir to ensure reliability of supply to the power station.
- A connection for the future pipeline to the Blue Mountains.
- Lidsdale Reservoir; an emergency supply and fire-fighting source for the power station.



Above: Duckmaloi Break Pressure Tank

Left: A Larner-Johnston needle valve used to regulate flows at both ends of the Break Pressure Tank. Regulation of the valve was controlled by a float in an adjacent chamber.

Rydal Emergency Storage

Raising of the dam proceeded in accordance with the original design. The work was undertaken by PWD day-labour with a construction village of 50 pre-fabricated cottages and living quarters for 100 single men established nearby.

Much of the equipment used on Stage 1 was still on site and was re-used. During the course of construction one major design change was made. The original design was for slab and buttress construction across the entire length of the dam. A decision was made to construct the left abutment of 145 metres (buttresses 1 to 41 in the original design) as an earth-fill embankment. The decision was based on economics. Earthmoving equipment was now readily available and the estimated cost of the revised design was considerably less than the original.

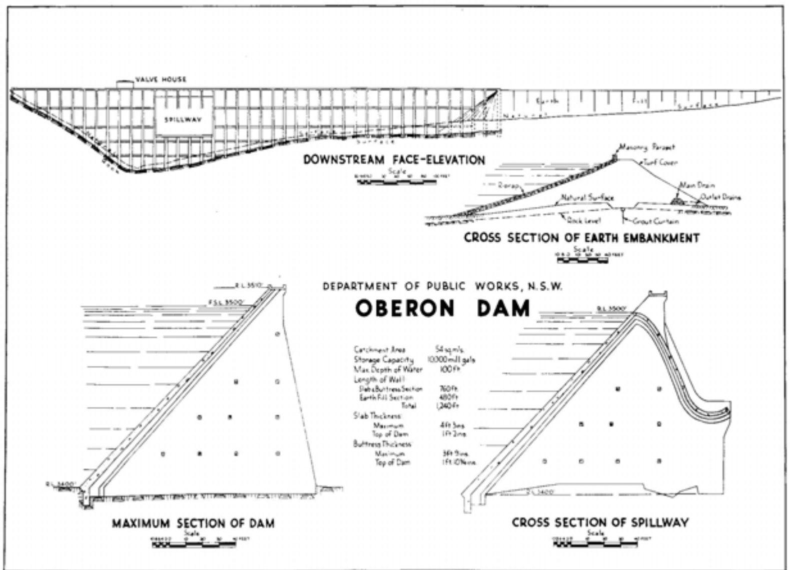


Diagram included in a PWD information booklet circa 1970

The controlling item of cost of construction was formwork building and handling - records suggest that the site engineers managed the following three basic processes very efficiently:

- handling of forms to minimise setting up time;
- effective and detailed construction planning to minimise movement of forms during the job; and
- design of forms to facilitate repetitive work, with a minimum of modification between the concrete pours. This was of critical importance as the buttresses were tapered in both directions.

While these efficiency issues had existed in Stage 1, the challenges were now increased because of the far greater height of the structure and the increased cost of labour.

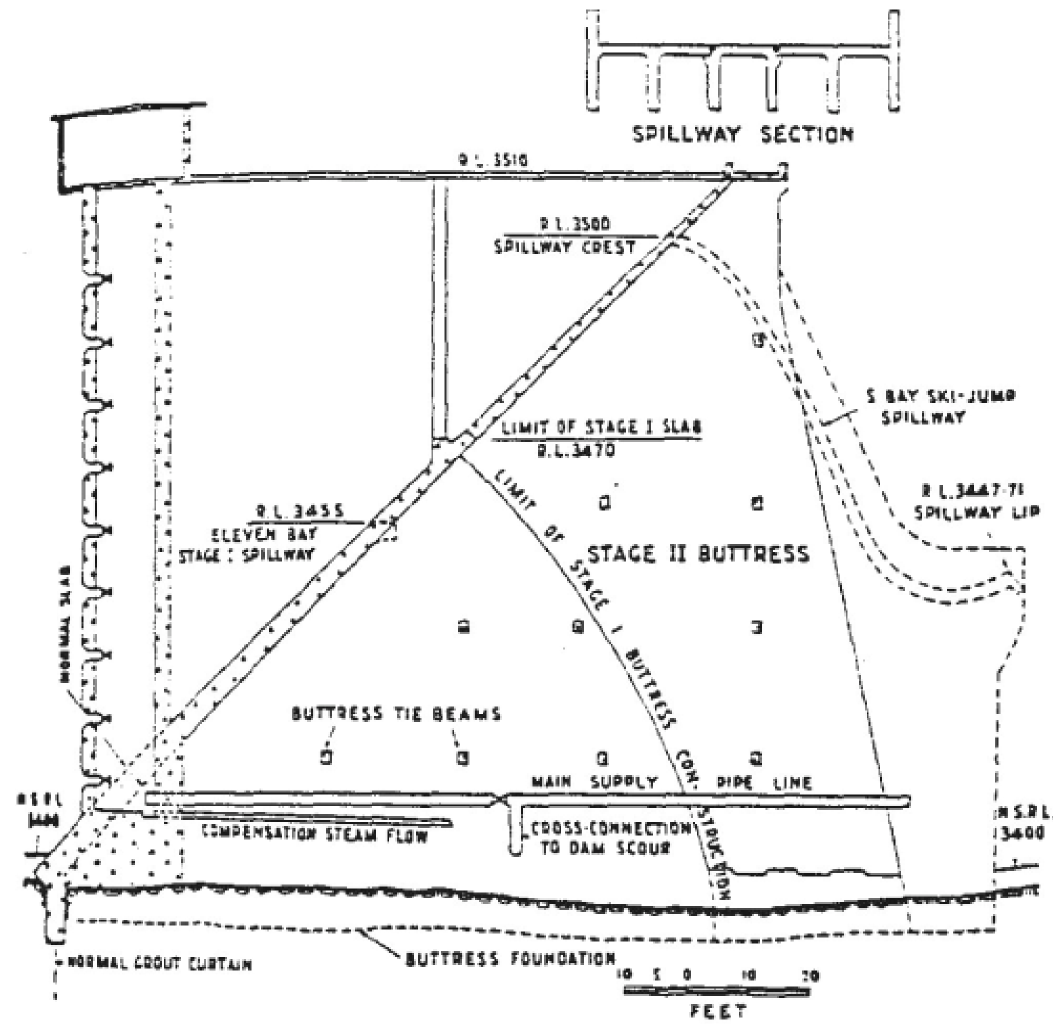
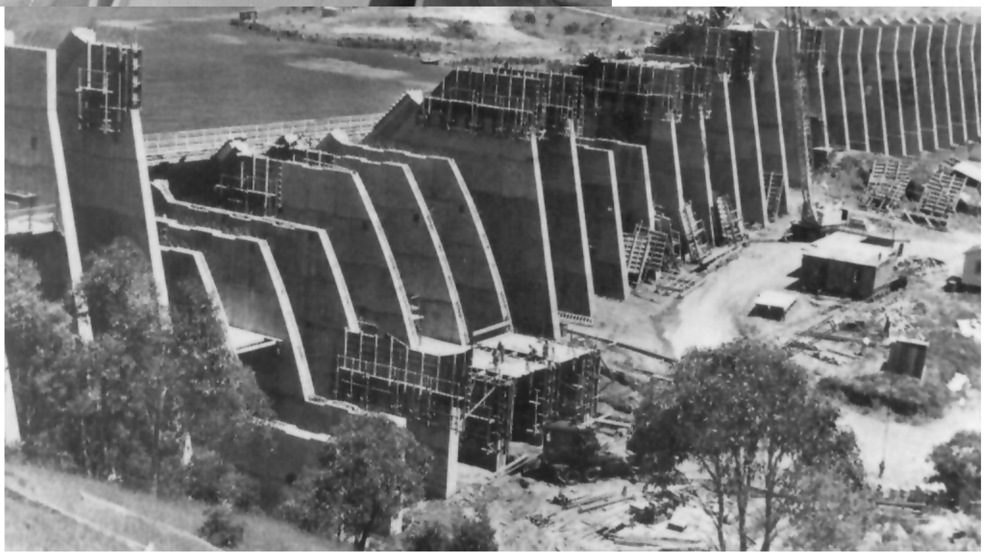
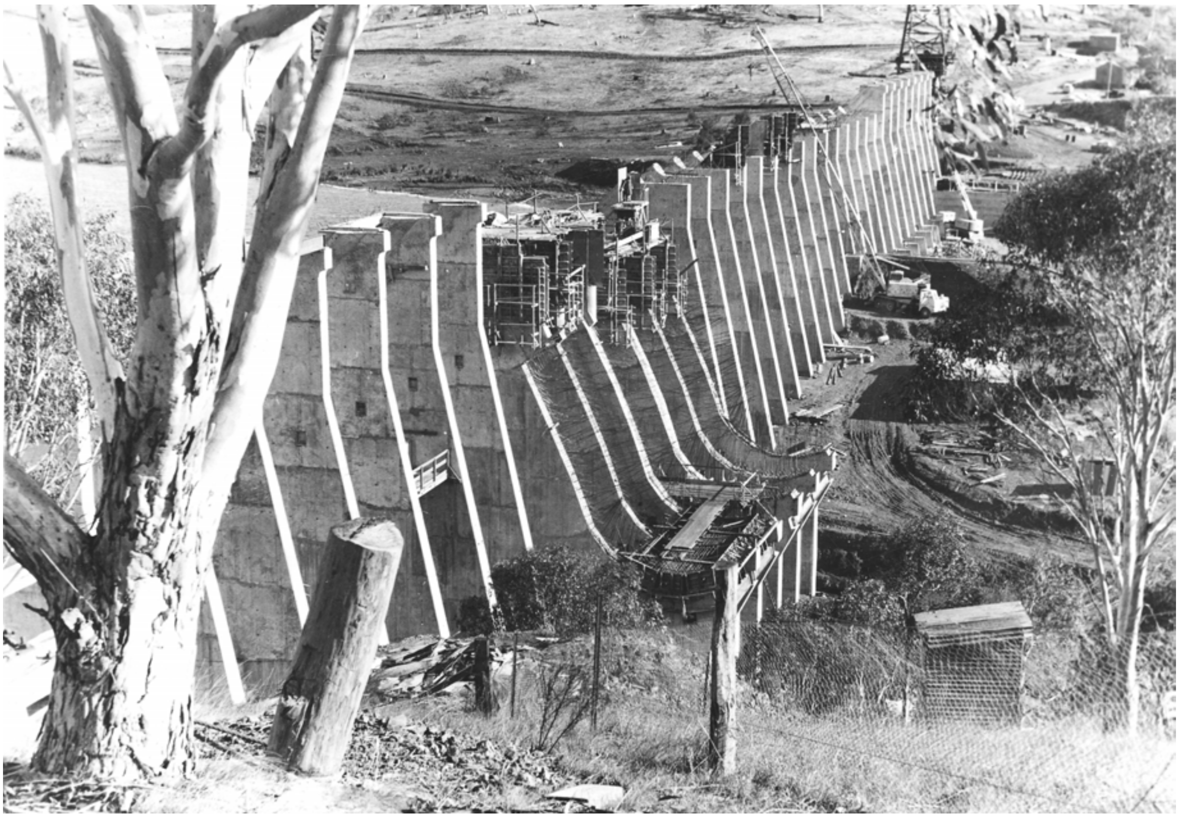


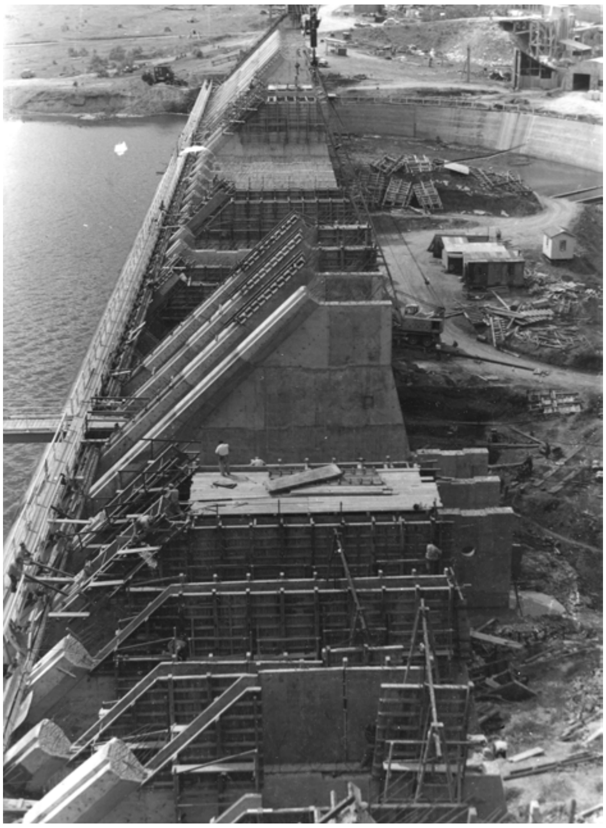
Fig. 12.—Oberon Dam—General Design.

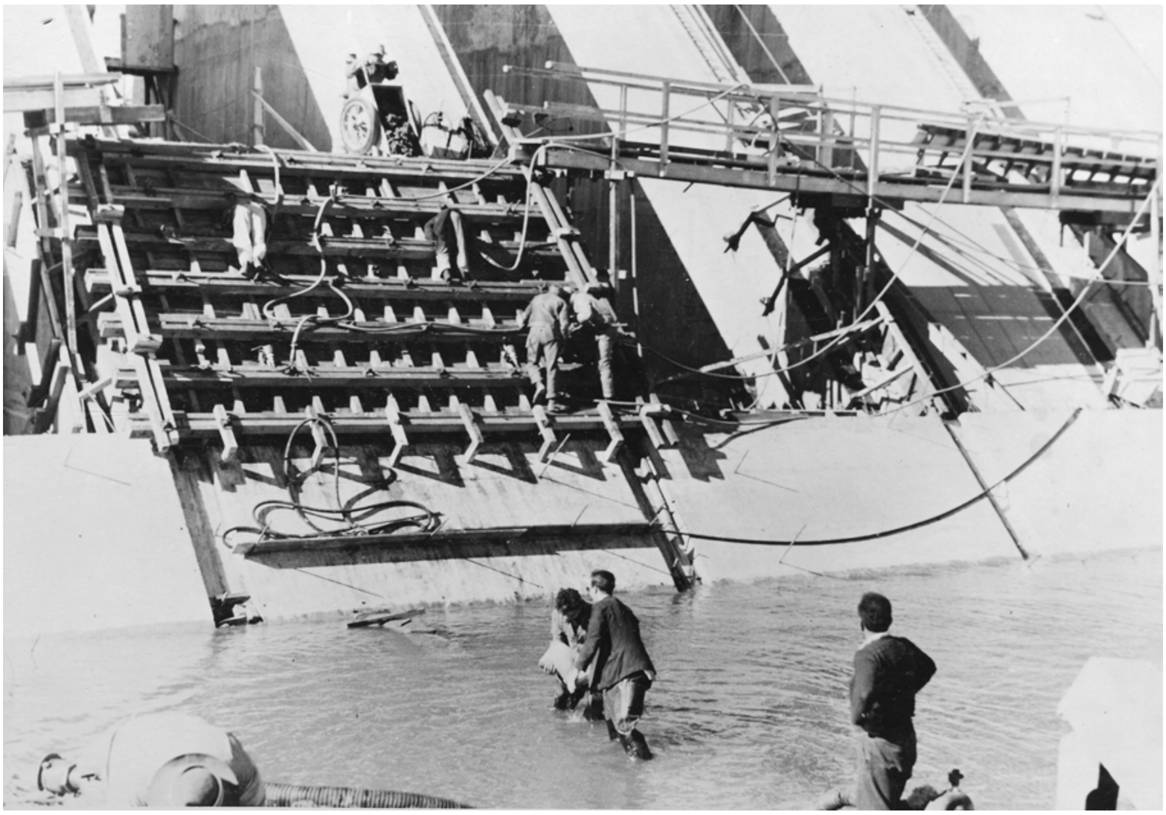
Diagram showing a section of the raised Oberon Dam and spillway taken from an article by LN Jamieson and BL Cantwell, “The Fish River Water Supply Development”, *The Journal of the Institution of Engineers, Australia* Vol 30 (June 1958), pp 159-167

Photographs taken during the Raising of Oberon Dam

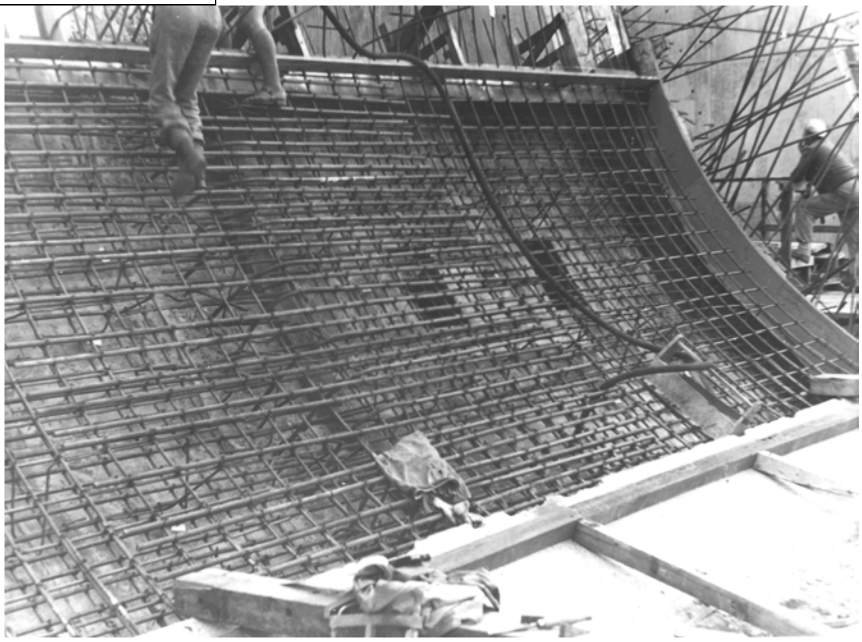


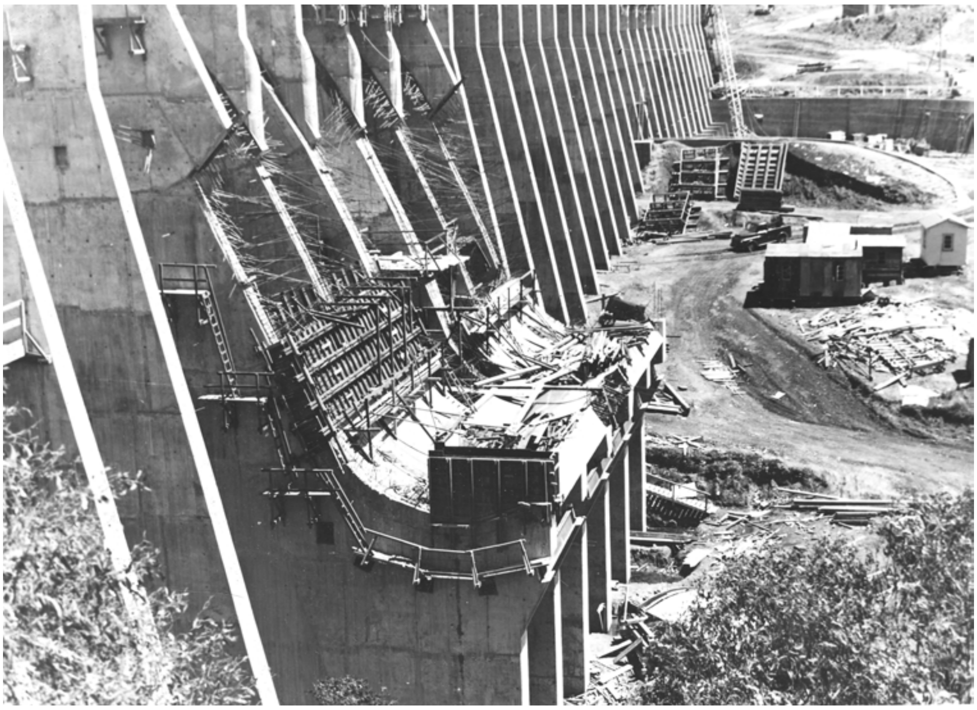


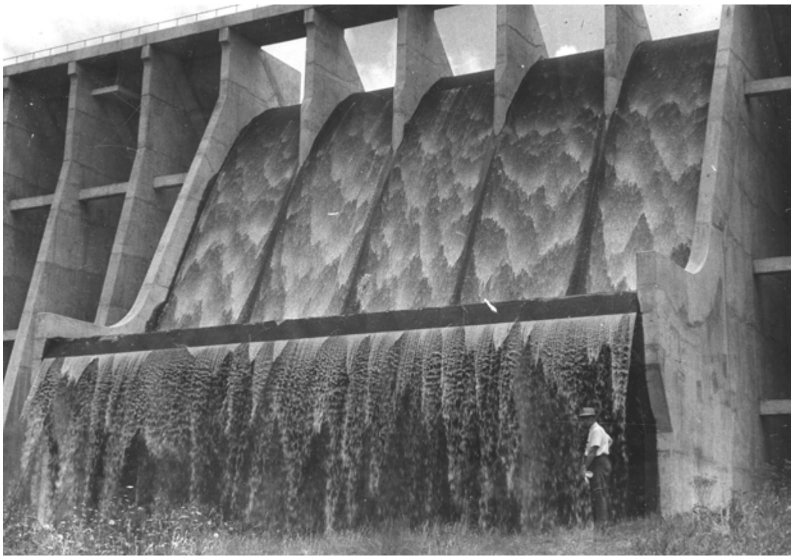


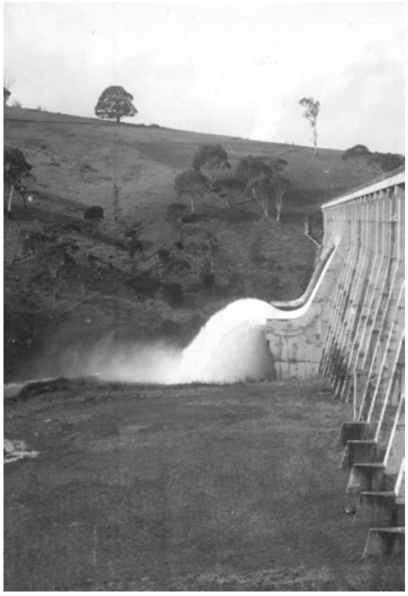


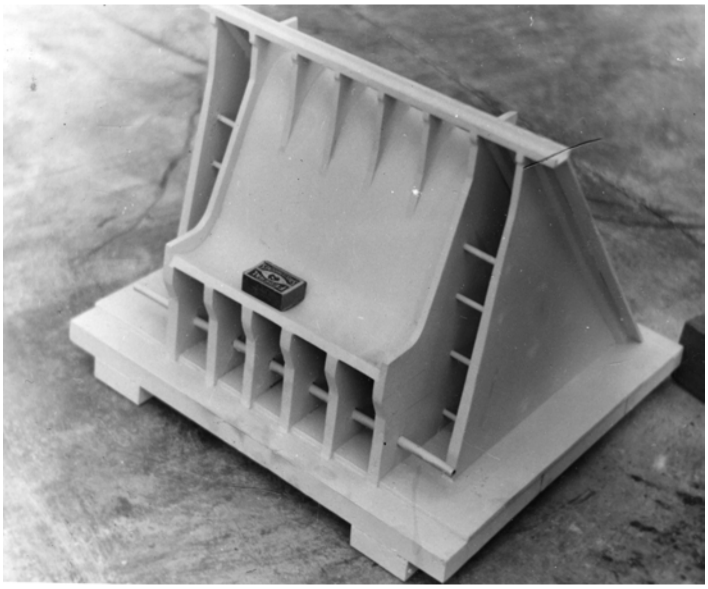
The Oberon Dam
Ski-Jump Spillway







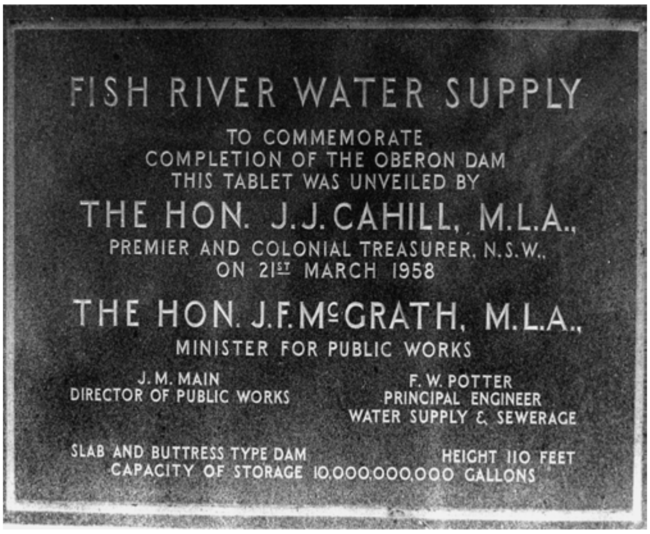




Spillway model used at Manly Laboratory

The raised dam included a ski-jump spillway. Extensive testing of a model at the PWD's Manly Hydraulics Laboratory was undertaken to ensure that high flows were thrown well clear of the structure and that scour from "dribble flows" would be minimised.

The dam was completed in 1957. Its construction proved to be an extremely well managed and efficient project; the planned construction period of 39 months was bettered by 13 weeks and the final cost exceeded the 1954 estimate by less than 1%.



There are only 7 major concrete slab and buttress dams in Australia; at 34 m Oberon Dam is the highest of these. It impounds 45,000 ML in Lake Oberon, more than double the storage of any other Australian slab and buttress dam.

DAM	*YEAR FINISHED*	*RIVER*	*NEAREST CITY*	*HEIGHT (m)*	*CREST LENGTH (m)*	*RESERVOIR CAPACITY (ML)*
Mount Paris	1936	Cascade	Launceston (Tas)	18	363	1,300
Lauriston	1941	Coliban	Kyneton (Vic)	33	441	20,000
Junction	1945	East Kiewa	Wodonga (Vic)	26	122	1,480
Oberon	1957	Fish	Oberon (NSW)	34	378	45,400
Coombing (Lake Rowlands)	1954	Coombing Rivulet	Carcoar (NSW)	20	236	7,520
Clover	1956	East Kiewa	Wodonga (Vic)	20	75	290
Yallourn Storage	1961	Latrobe	Yallourn (Vic)	21	118	8,020

TABLE 1 – Large Australian Concrete Slab and Buttress Dams (source: ANCOLD)

As the projected demands for the new Wallerawang power station and the Blue Mountains of nearly 60 ML/d were some six times the capacity of the existing pipeline, a new pipeline was essential.

The limitations imposed on the Stage 1 pipeline resulting from the lack of availability of materials during the war, no longer existed. A re-examination was made of the best way to deliver water from Oberon to Wallerawang with consideration being given to a route that required pumping to a balance tank at a high point on the Great Dividing Range and then following the ridge. This option would have allowed for relatively easy construction. However, the alternative route adjacent to the existing pipeline was chosen because it allowed for gravity flow, with consequent long term savings in maintenance and energy costs. It also permitted cross connection with the Stage 1 pipeline at regular intervals, thus providing flexibility of operation and minimising of disruption during maintenance and repair activity.

Once again, welded steel pipe was the chosen material and tenders were called on this basis. However, alternatives were considered and the lowest tender was from Rocla Industries for a pre-stressed concrete pipeline. After an extensive review, the contract was awarded to Rocla, thus beginning a significant piece of Australian engineering history.

The project attracted great interest, as it was the first in Australia to incorporate pre-stressed concrete pipe (PSC) pipe into a water supply system. The contract was so large that a special pipe manufacturing plant was built at Lithgow. There 10,000 pipes were manufactured, which together with 1.6 km of steel pipeline for above ground sections and creek crossings would form a 54 kilometre long pipeline.

It remains the longest pre-stressed concrete water supply pipeline in Australia and records of a longer PSC pipeline in the world have not been found.

The pipes were 4.8 m long and were manufactured by spirally winding a longitudinally reinforced socketed concrete pipe with a high tensile pre-stressing wire, with the tensioned wire protected by a coating of pneumatically applied mortar. The manoeuvring and jointing of the heavy pipes in the rough and steep terrain was a most difficult task - the largest pipe weighed 2.3 tonnes.

In some cases, through country with grades as steep as 1 in 2 over distances of more than 300 metres, two bulldozers were used in tandem to assist the excavator and the pipelaying machine on account of the combination of the steepness of grade and the looseness of the gravel encountered. Failure to maintain the proper support as each pipe was transported and moved into position was likely to result in a “broken back”.

The first pipes were produced in the Lithgow factory in January 1957 and manufacture continued until November 1958. Pipeline construction began in March 1957 and was complete in April 1959.

In hindsight, the decision to adopt PSC because of a relatively small saving in capital cost was not wise. A steel pipeline would have had no need of repair or significant maintenance for many years, although at the time of awarding the contract that expectation applied equally to PSC.

However, from the outset, there were problems with the pre-stressed concrete line. Its history has been punctuated by regular leaks and blow-outs. Accordingly, it has been necessary for the scheme to maintain a specialist construction team, skilled in the repair of this unusual pipe.

A particular difficulty is the joining of cut pipes when a repair is required. The rough external surface caused by the pneumatically applied concrete layer means that normal compression joints cannot be used. Despite nearly 50 years of experimentation and testing the only jointing system found to be reliable in the high head areas is the fitting of a welded steel sleeve and jointing with molten lead. Lead joints are no longer used in the water industry and it has been necessary to retain lead jointing skills within the scheme's maintenance team.

While FRWS has paid a price as a result of pioneering the use of PSC pipe, the water industry at large has benefited. The problems experienced by FRWS [such as insufficient longitudinal reinforcement, the design of the rubber jointing ring and quality control of the concrete covering of the pre-stressing wire] were subsequently addressed by the manufacturer, and it is understood that later PSC pipelines in other locations have performed well.

Above Left: A typical break of the pre-stressed concrete pipeline

Above: The rough barrel of the pipeline is clearly visible in this view

Left: Repairing a break in the pipeline - pouring a lead joint

Stage 3
A short delay, which occurred only because of a lack of funds, separated Stage 2 from Stage 3, which included the supply to the Blue Mountains and a small supplementation of the source.

The major change to the 1941 concept was supply by gravity from Oberon to Leura, made possible by taking water under the Great Dividing Range, designing the pipeline for exceptionally high heads as it traversed Kanimbla and Megalong Valleys and overcoming the formidable construction difficulties in ascending the cliffs of the Narrow Neck Peninsular. The height of the cliff from Megalong Valley to the top of Narrow Neck Peninsular is some 250 metres, most of it very rocky and steep. In one section it was necessary to attach a 30 metre vertical section of pipelineto the rock face.

The major components of the Stage 3 augmentation were:

- A tunnel, 1100 metres long at Hampton beneath the Great Dividing Range, some 44 metres below the surface at the highest point of the range.
- A 40 km pipeline to Leura from the off-take on the Stage 2 main. With diameters ranging from 450mm to 600mm, the cement lined welded steel pipeline had to withstand a head of 560 metres of water at its lowest point, which was then the greatest pressure in any water supply pipeline in Australia. A wall thickness of 20 mm was required in the highest head areas.
- A small weir on the Duckmaloi River.

Work began before the Stage 2 project was completed and finished on schedule in mid 1964.

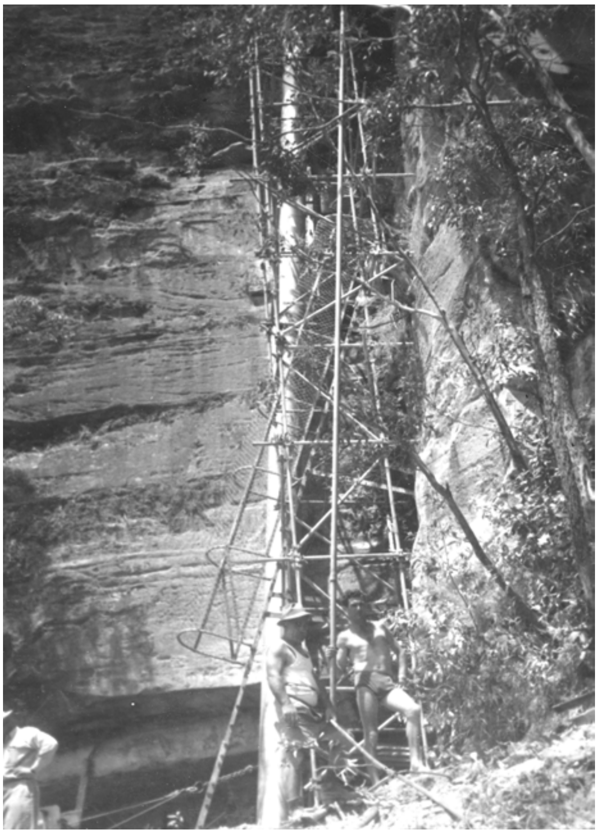
There was no debate about the material to be used for the Leura pipeline. Steel was the only practical material that could withstand the pressures that were to be encountered.

The performance of the pipeline has been outstanding. There has not been a single failure or leak since it went into service. There has been only one repair, following the puncturing of the pipe by the rippers of a bulldozer in 1976. The accident occurred in an area of very high pressure in Megalong Valley; the bulldozer was overturned and its operator was lucky to escape without serious injury.

Aerial view of Narrow Neck peninsular showing the point where the pipeline is attached vertically to the cliff.

Above: Duckmaloi Weir under construction in 1963

Below: Duckmaloi Weir spilling in 1986

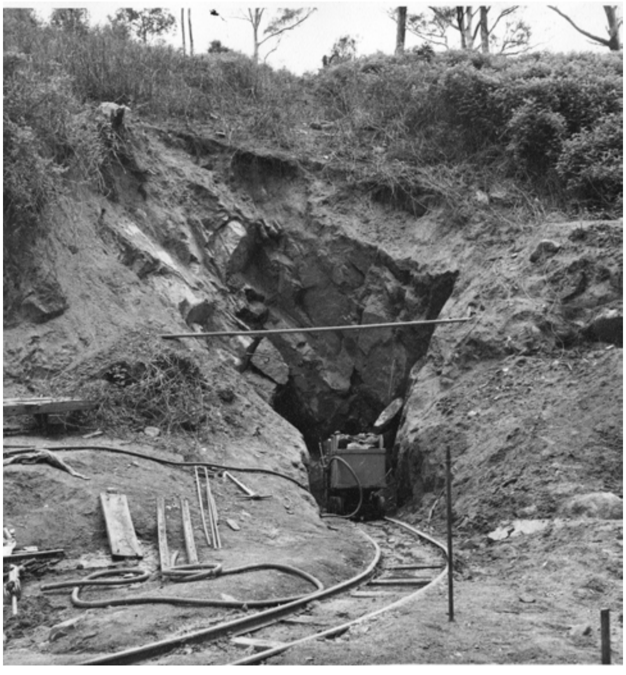


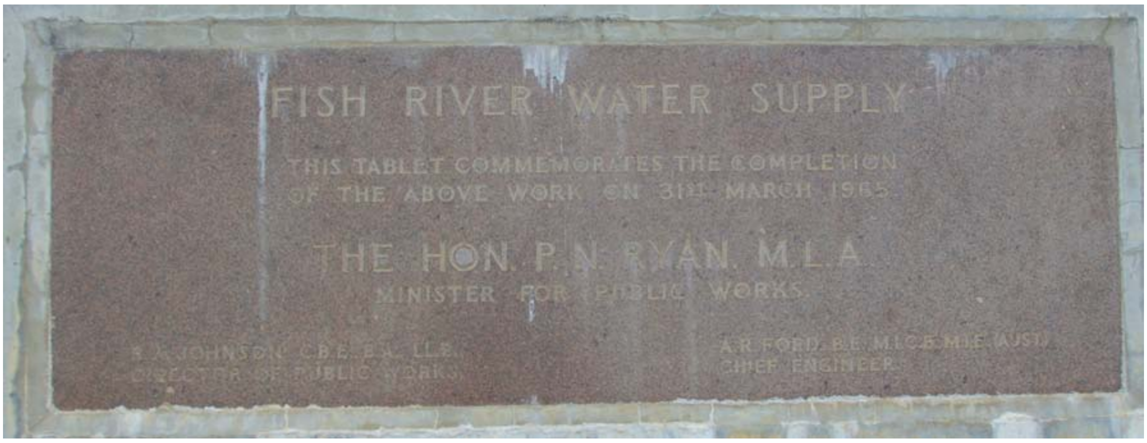
Above left: The vertical section of the Stage 3 pipeline at the bottom of the cliff at Narrow Neck peninsular.

Above right: Near the top of the vertical section of the pipeline.

Left: The pipeline leaves the cliff via a narrow cleft in the rock face

Right & below: Hampton Tunnel - the downstream adit, during construction and completed





Plaque commemorating completion of Fish River Water Supply – March 1965

Subsequent developments

Since the completion of Stage 3 there have been minor improvements to the system. A booster pumping station was constructed in 1976 at Narrow Neck allowing flows to Leura to be boosted from 11.5 ML/d to 18.2 ML/d.

Narrow Neck Booster Pump Station – note the sloping roof, later covered with soil and planted with native vegetation, to minimise the environmental impact of the pump station.

A new booster pumping station was commissioned at East Wallerawang in 1984 increasing the maximum rate of delivery to Lithgow.

A water treatment plant came into service at Duckmaloi in 1991. Its object is to maximise the yield from Duckmaloi Weir. Because the storage is so small significant quantities of water are available only for short periods during rainfall and flows are frequently highly turbid as the storage is too small to permit settlement. Thus without treatment most of the flow was too turbid to be used.

Changes to the delivery pipelines were made in the early 1990s when Mt Piper Power Station was commissioned. Although no increase in demand occurred [the safe yield of the FRWS system was already fully allocated] water from FRWS was needed at Mt Piper for boiler feed. A corresponding reduction in cooling water supplied at Wallerawang Power Station was made up from Pacific Power's Lake Lyell source on the Coxs River. A large pumping station was built with a ductile iron pipeline delivering FRWS water to terminal storages on the Mt Piper Power Station site.

The only other significant works carried out on FRWS were new fuse-plug spillways at both Oberon and Rydal dams completed in 1995, to handle the revised predicted maximum probable flood.

Re-location of the FRWS Lithgow pipeline across Lake Wallace at Wallerawang.

Lake Wallace was constructed by the Electricity Commission on the Coxs River as a cooling water reservoir for the adjacent Wallerawang Power Station.

East Wallerawang Pump Station

Abandonment of Further Headworks Capacity
It is important to mention the major augmentation of FRWS that did *not* occur.

In 1953 a PWD report presented a preliminary proposal to develop the headworks capacity of the system to 27,000 ML per annum, nearly double that of Oberon Dam plus Duckmaloi Weir. It recommended planning for "the ultimate economic development of the Fish River Water Supply System". The proposal was based on a large high level dam on the Duckmaloi River just below the weir, supplemented by a series of high level pipehead weirs located on seven nearby creeks feeding directly to the main pipelines. In addition, there was to be reserve storage of about 18,000 ML at Tarana on the Fish River and a 7000 ML terminal storage at Angus Place north of Lithgow.

All work in Stages 2 and 3 was carried out in conformity with this 1953 proposal, and the incorporation of the additional sources into the system would have been a simple and cost-effective matter.

By 1978, demand had increased to a level where planning for headworks augmentation was initiated. However, environmental considerations related to further diversion of westerly flowing water to the east of the Great Dividing Range became paramount. Despite significant cost advantages over alternative schemes and the good progress already made on the design of Duckmaloi Dam the then Minister of Public Works, Jack Ferguson decided that there would be no further easterly diversion of westerly flowing water. All work on headworks development ceased and at present it is unlikely that any augmentation of the Oberon Dam/Duckmaloi Weir source will ever occur. The additional demands that would have been met by an augmented FRWS have been satisfied in a variety of ways.

A large dam has been built on the Cox's River to supply cooling water to Wallerawang and Mount Piper Power Stations, Lithgow has introduced the Clarence Transfer System (which carries water across catchments to feed Council's Farmers Creek Dams) and Sydney Water has constructed a supply system to pump water to the lower and mid Blue Mountains from the Warragamba system.

5.2.2 Historic individuals and association

5.2.2.1 FRWS has association with many engineers of distinction:

- A R Blair wrote the "Report on the Blue Mountains District Water Supply", AR Blair and Stuckey, Sydney, 1939. The report contains some of the essential elements of the later proposals of Haskins and Jones related to a district-wide water supply, although it was not based on supply from the Fish River
- The eminent consulting engineer Gerard Haskins, one of the founders of the firm, Gutteridge, Haskins and Davey [now GHD] and a highly respected consulting engineer. He is regarded as the creative genius behind the broad outlines of the Fish River Water Supply.
- Stephen Jones, Principal Engineer Water Supply and Sewerage 1938-49 of PWD. The Jones report was the PWD's blueprint for the scheme as it unfolded.
- Jones' influence in the department was considerable. He was an experienced engineer serving as Principal Designing Engineer from 1934-38 and as Principal Engineer of

Water Supply and Sewerage from 1938 until his retirement in 1949. It was his 1941 report that provided the key engineering document in the State and Commonwealth Government discussions and negotiations in the 1942-1943 period. It was also Jones who, at critical moments in Commonwealth Government decision-making, pressed the case for the Fish River scheme. As a senior engineer in PWD he also played an important liaison role between the two governments during the construction of Stage One.

5.2.2.2 The scheme is also one of the major achievements of the NSW Public Works Department that was founded in 1856 and was responsible for the design and construction of water supply and sewerage schemes for country towns throughout the State, from the 1880s through to the mid 1990s. The Department employed many historically notable engineers some of whom contributed to the FRWS as designers, managers of construction and of the operation of the system.

5.2.3 Creative or technical achievement

5.2.3.1 The earliest concept of the scheme envisaged a dam near Oberon on the Fish River Creek to provide supply by gravity to most users. It did include the prospect of two pumping stations; one for the supply to Oberon and one for supply to the Blue Mountains. However, while the Oberon pumps were needed and installed, the Blue Mountains pumps were eliminated by providing a gravity supply to Leura at a lower elevation.

As a predominately gravity scheme it was an economically sound way to satisfy the water needs of industry and communities throughout the region, across four local government areas.

5.2.3.2 Oberon was the first slab and buttress, or Ambursen dam built in NSW. Only one other of this type has been built in the State; the much smaller being Coombing Dam near Carcoar, on a catchment adjoining Fish River, which was designed and built by Gutteridge Haskins and Davey.

The Public Works Department showed foresight by arranging in its design that the favourable dam site would not be expended on a small structure and so made provision for full economic development of the site.

Oberon Dam,

- at 33.5 m is the highest of the 7 major slab and buttress dams in Australia;
- impounds 45,000 ML in Lake Oberon, more than double the storage of any other slab and buttress dam;
- incorporates a ski-jump spillway in the main wall. Modelled at Manly Hydraulics Laboratory, the spillway has performed well with no erosion problems from either flood flows or “dribble” flows; and
- has performed well in service, requiring no significant repairs.

Raising the dam to its full height was completed ahead of time and to budget, and the extensive documentation still available indicates that the management of the project was a model of excellence.

5.2.3.3 The 105 km long pipeline from Oberon Dam to Glen Davis which supplied the National Oil Refinery was constructed of a variety of materials, because of materials constraints during WWII. It comprises:

5 km cement-lined welded steel *[very high head areas]*
82 km cement-lined lead-jointed cast iron *[heads above 99 metres]*
14 km reinforced concrete
4 km fibro

To avoid the very high pressures that would be encountered in the descent from the Great Dividing Range at Baal Bone Gap to the valley in which Glen Davis is situated, a pressure-reducing valve and four break-pressure tanks were installed in the pipeline. This permitted the use of lighter duty pipes.

Although now 60 years old, the pipeline is still in use, and performing reliably.

5.2.3.4 A 40 km pipeline was constructed to Leura from the off-take on the Stage 2 main. With diameters ranging from 450mm to 600mm, the cement lined welded steel pipeline had to withstand a head of 560 metres of water at its lowest point, which, at the time, was the greatest pressure in any water supply pipeline in Australia. The performance of the pipeline has been outstanding. There has not been a single failure or leak since it went into service.

5.2.4 Research potential – teaching and understanding

5.2.4.1 Full development of the catchment was intended with the construction of a second dam on the Duckmaloi River, another western flowing stream. This "ultimate economic development of the Fish River Water Supply System" [PWD Report, 1953] would have provided a very attractive solution to the problems of increasing demands in the area in the 1980s, with significant cost advantages over any alternative scheme. Indeed, the design for the new dam was well advanced.

In a landmark decision in 1978 the Minister for Public Works, Jack Ferguson, decided there would be no further easterly diversion of westerly flowing water.

This decision to abandon the most attractive option, the lowest in both capital and operating cost on purely environmental grounds was of great historical significance in relation to the management of water resources in Australia, and is an important topic for research into the development of the environmental movement.

5.2.4.2 The pipeline from Oberon to Wallerawang, completed in 1959 is the longest prestressed concrete pipeline in Australia and no record has been found of a longer pipeline of this type anywhere in the world. It is 52.4 km long with diameters ranging between 625 to 825 mm, with design heads of up to 250 m.

The pipeline established engineering history in Australia as it was the first PSC pipe incorporated into a water supply scheme.

The reliability of the PSC pipeline has been poor. However, as a result of the experience on FRWS the manufacturer made several design changes and it is understood subsequent PSC

pipelines have performed well. In other words the failures have contributed significantly to the development of reliable designs for PSC pipelines.

Despite the difficulties, the pipeline remains in service, although some of the more unreliable sections have been replaced in other materials

5.2.4.3 The history of the FRWS and of the funding negotiations between the Commonwealth and State governments, including the part played by the outbreak of WWII in resolving their differences, provide an interesting topic for political research.

The history of the FRWS is also a significant part of the history of the shale oil industry generally, and in particular of the history of the Glen Davis shale oil works, which needed a substantial and reliable supply of water to sustain the operation.

A water supply scheme to service Portland, Wallerawang, Oberon and Lithgow had been on the agenda since at least 1937, but was delayed by economics considerations and funding. These and the resolve to proceed with construction continued until Japan's entry into the Second World War in December 1941, when the need for an indigenous supply of petrol emerged and by February 1942, was seen as critical by the Commonwealth Minister for Supply & Shipping.

However, the ability of the Glen Davis deposit to provide an alternative to imported petrol during the war was hampered by deficiencies in both the volume and quality of the necessary water. To overcome the problem, National Oil Pty Ltd (the company operating the Glen Davis deposit) recommended the FRWS to the Commonwealth government with the backing of the PWD.

After considerable political delay, particularly over funding and the resolution of cost sharing arrangements, the scheme was finally approved on 29 June 1943 with the engineering work to be by the PWD under the supervision of the Allied Works Council, as it was a priority defence project.

5.2.4.4 The FRWS also provides an avenue for research into the activities of the Civil Constructional Corps which was involved in construction of Stage 1 of the dam and the pipeline to Glen Davis, as the work was a priority defence project. At the peak of activity there were 400 men engaged on the project.

The CCC which was disbanded in October 1945 following the end of the WWII, played a most significant, but now largely forgotten role in the provision of works considered necessary for the defence of Australia. Because the majority of these works were related to military activity in time of war, there are few visible reminders of the work of the CCC.

FRWS, which has been an essential service since its commissioning is a tangible reminder of the important work undertaken by the CCC.

5.2.4.5 The large platypus colony at Duckmaloi Weir remains an important site for research and has been so used by Charles Sturt University. The colony is likely to remain undisturbed for the foreseeable future.

5.2.5 Social or cultural

5.2.5.1 From its inception, FRWS has had a significant social impact. Primarily it provided substantial social benefits through the provision of a safe and reliable water supply to urban and rural consumers and to industry.

It brought safe reticulated water to Oberon, Wallerawang, Portland, Rydal and Lidsdale. Severe water restrictions in Lithgow were eliminated and after construction of the pipeline to Leura, similar relief was provided to the residents of the central Blue Mountains. Water consumers in the FRWS area of supply thus had reticulated water in both quality and quantity to support a lifestyle that could match that of the major cities.

Further beneficial effects occurred along the routes of the pipelines. “Minor Consumer” connections were granted to owners through whose properties the pipelines passed, with water from such connections available for domestic and stock watering purposes.

For much of their lengths the pipelines are very close to the ridge of the Great Dividing Range. Properties in such areas frequently have no permanent creeks, being so close to the headwaters. Consequently the provision of a secure water supply for drinking and stock watering was an enormous benefit to the more than 250 landholders who took the opportunity to connect.

5.2.5.2 Construction of the dam brought growth and an economic upsurge to Oberon, and the Stage 2 pipeline provided a much-needed impetus to employment in Lithgow after the war.

In 1943 Oberon was an isolated community of less than 1000 people. Its access to the “outside world” was via narrow rough roads that were frequently cut after rain at the several fords. The town was also often isolated in winter for days at a time by heavy snowfalls. There were few visitors from beyond the local area.

The dam construction brought a large, temporary increase in Oberon's population and thereby a significant boost to the economy of the town. The construction camp required food and other provisions and the construction site needed materials and local support for maintenance of the heavy equipment being used.

Although a slump in the town's commercial activity followed completion of Stage 1 of construction, Oberon was re-vitalised when Stage 2 got under way in 1954. The town has not looked back since, having shown steady growth during the later stages of construction and subsequently.

By the time Stage 2 commenced in 1954, Lithgow was suffering a serious slump following the closure of several wartime industries. Thus the employment created by the manufacture of the pre-stressed concrete pipes and the construction of the pipeline was an important contributor to the economic recovery of the town

5.2.5.3 Construction work and the transport of pipes and materials stimulated the upgrading of the district’s road network.

In the mid 1950s, transport of the massive pre-stressed concrete pipes and movement of construction vehicles put an unprecedented strain on local roads, which had hardly changed in

the previous 50 years. Major programs of road widening and sealing began with the advent of the FRWS, more frequent maintenance was introduced and all of the fords that had so frequently been the cause of traffic disruption were replaced by bridges and culverts. Although the FRWS cannot take direct credit for the improved road network, the traffic it generated was a significant catalyst in the decisions by local government authorities to undertake major road system upgrades.

The improved roads made the area far more accessible and tourists began to travel in numbers to visit the Central Highlands with its scenic splendour; the isolation of the area was no more.

5.2.5.4 Recreation and tourism are continuing social benefits provided by FRWS. The picnic area at Oberon Dam is an extensive and well used facility, and both sailing and trout fishing at Lake Oberon are important local recreation activities and tourist attractions.

5.2.6 Rarity

5.6.1 FRWS is unique as the only scheme in eastern Australia to transfer western flowing water to east of the Great Dividing Range; approximately 70% of its water is delivered to consumers east of the Range.

5.2.7 Representativeness

5.2.7.1 The FRWS is an excellent example of a regional water supply scheme – a scheme that serves domestic, industrial and rural consumers.

5.2.7.2 Oberon dam is a superb example of an Ambursen slab and buttress dam. It:

- is the first dam of the type built in NSW
- is the highest of the type in Australia; and
- it impounds more than double the storage of any other Australian slab and buttress dam..

5.2.7.3 The 40 km pipeline to Leura is subjected to a head of 560 metres of water at its lowest point; at the time of construction, it was the greatest pressure in any water supply pipeline in Australia. Its performance has been outstanding and without a single failure or leak since going into service.

6.0 STATEMENT OF SIGNIFICANCE

6.1 The FRWS is an excellent example of a regional water supply scheme – a scheme that serves domestic, industrial and rural consumers.

6.2 FRWS is unique as the only scheme in eastern Australia to transfer western flowing water to east of the Great Dividing Range; approximately 70% of its water is delivered to consumers east of the Range.

6.3 Construction of the scheme brought significant social benefits to the Central Tablelands of NSW in providing a safe and reliable water supply; in stimulating development at Oberon and providing employment there and at Lithgow during downturns in economic activity; in stimulating road improvements and eliminating the isolation of Oberon during wet weather and snow falls; and by improving accessibility has encouraged recreation and tourism.

6.4 Oberon dam is a superb example of an Ambursen slab and buttress dam. It is the first dam of the type built in NSW and is the highest of the type in Australia.

6.5 Although the dam was constructed in two stages there was foresight in ensuring that full economic development could be made of the favourable dam site.

6.6 The 105 km long, 60 years old pipeline from Oberon Dam to Glen Davis, although constructed of a variety of materials because of war-time constraints is still in use and performing reliably.

6.7 At Narrow Neck, the 40 km pipeline to Leura ascends 239 metres over a 340 metre horizontal distance, including a vertical cliff 30m high. The pipeline withstands a head of 560 metres of water at its lowest point; at the time, and possibly still, the greatest pressure in any water supply pipeline in Australia. Its performance has been outstanding.

6.8 The scheme has research potential in regard to:

- the decision to abandon full economic development of the catchment on environmental grounds;
- funding negotiations between the Commonwealth and NSW governments;
- development of expertise in the design of pre-stressed concrete pipes;
- the activities of the Civil Constructional Corps during World War 2; and
- the platypus through the large colony at Duckmaloi Weir.

6.9 The scheme has associations with eminent consulting engineers A R Blair, Gerard Haskins and Public Works engineer Stephen Jones. It also has association with the Public Works Department that constructed the basic infrastructure of NSW and constructed country town water supply and sewerage schemes from the 1880s to the mid 1990s.

7.0 CITATION

The wording proposed for information plaque is.

Fish River Water Supply Scheme

Engineered by the NSW Public Works Department this scheme commenced in October 1943 to supply water to the Glen Davis shale oil works, with Stage 1 being constructed by the Civil Constructional Corps during World War 2. At 33.5m, Oberon Dam on the Fish River is the highest slab and buttress dam in Australia and except for pumping to Oberon, gravitates water to towns, the upper Blue Mountains, rural consumers and Wallerawang and Mount Piper power stations. The scheme is unique in transferring western flowing water to east of the Great Dividing Range. The pipeline to Wallerawang power station was the first and remains the longest pre-stressed concrete water supply pipeline in Australia; the steel pipeline to Leura ascends Narrow Neck vertically and at the time sustained the greatest pressure of any in Australia. The concept of the scheme was progressively developed by consulting engineers A R Blair, G Haskins and Public Works Principal Engineer Water Supply, S Jones.

The Institution of Engineers Australia
State Water Corporation NSW 2008

8.0 REFERENCES

8.1 Books and Pamphlets

1. R McLachlan, D Barrett, J Domis and N Welling, *Let's Have Water – A History of the Fish River Water Supply,* Department of Land and Water Conservation, 1997.
2. B Cole [Editor], *Dam Technology in Australia 1850-1999,* ANCOLD, 2000.

8.2 Articles

1. *Buttress and Slab Dam at Oberon for Blue Mountains Water Supply,* Contracting and Construction Equipment Vol 10, No 10, June 1957, pp 9-14.
2. *Prestressed Pipeline for Fish River Water Supply Scheme,* Constructional Review Vol 32, No 3, March 1959, 99 18-23
3. *Fish River Water Supply, Stage 3,* Stateworks Vol 7, No 1, February 1962, p 13.
4. *Specially Designed Ski-Jump Spillway in Operation at Oberon Dam [Cover Photo].* Stateworks Vol 7, No 3, June 1962, cover.
5. *High Head on Blue Mountains Pipeline,* Contracting and Construction Equipment Vol 15, No 12, August 1962, pp 78-79, 82-83.
6. *Ambursen Type Dam at Oberon, NSW,* H S Cornish, Commonwealth Engineer, Vol 39, No 4, November 1, 1951, pp 154 – 162.
7. *The Fish River Water Supply Development,* L N Jamieson and B L Cantwell, Journal of the Institution of Engineers Australia, Vol 30, June 1958, pp 159-167.

8.3 Additional

1. Additional references are in *Appendix 1 – Sources Consulted* of *"Let's Have Water – A History of the Fish River Water Supply"*

In the original submission this page is replaced by an envelope containing a CD-ROM holding the files that make up this document, plus all of the images so far collected and scanned.